2. This is the eclipse of Stiklastad, and Mr. Stockwell's computations appear to satisfy the account given by Hansen in vol. ii., p. 388, of his "Darlegung."

3. Observed at Alexandria by Theon.

4. An annular eclipse which occurred before sunrise in any part of Mesopotamia, so that it could not have occasioned the phenomenon mentioned by Ammianus Marcellinus (book xx. chap. 3).

5. This eclipse was total in the eastern parts of Mesopotamia at 9h. 50m., and satisfies the phenomenon described by Ammianus.

6. The eclipse encountered by the fleet of Agathocles while on its voyage from Sicily to Africa.

7. The eclipse described by Thucydides as having occurred during the eighth year of the Peloponnesian War.

8. This eclipse is shown to be identical with that described by Thucydides as having occurred during the first year of the Peloponnesian War, when the darkness was so great that some of the stars were visible.

9. The account given by Aristides ("Scholiast," ed. Frommel, p. 222) of the eclipse which took place while Xerxes was on the march from Sardis to Abydos at the beginning of the Persian War is confirmed by the computations.

10. This is shown to explain the disappearance of the sun described by Xenophon ("Anabasis," Book iii.) as having occurred at Larissa.

11. Contrary to the conclusions of Hansen and Prof. Airy, Mr. Stockwell finds that this eclipse does not satisfy Xenophon's account.

12, 13, and 14. Each of these has been supposed to be Thales's eclipse. Mr. Stockwell finds that both 13 and 14 satisfy equally well the astronomical conditions of the problem, but thinks the former is rather the more probable of the two.

15. The record of this eclipse was discovered on the Assyrian tablets in the British Museum, and the computations show that an eclipse happened at Nineveh at two o'clock in the afternoon on the date given.

16. Homer mentions a singular darkness that occurred during one of the great battles of the last year of the Trojan War ("Iliad," Book xvi.). Mr. Stockwell explains the darkness by means of this total solar eclipse.

Many of the conclusions arrived at with respect to the dates of eclipses differ widely from those generally accepted, and are open to much discussion.

COGGIA'S COMET (*b* 1890).—*Edinburgh Circular* No. 9 contains the following elements and ephemeris, computed by Dr. Berberich, of Berlin, from observations made at Marseilles on July 19, and at Kiel on July 21 and 22. Dr. Berberich finds there must be an error in the comet's place deduced at Marseilles on July 18, the date of discovery. He also points out that the orbit closely resembles that of the comet of A.D. 1580.

Elements of Comet Coggia.

$$T = 1890 \text{ July } 7{\cdot}9775 \text{ Berlin Mean Time.}$$

$$\left.\begin{array}{rl} \pi - \Omega = & 84^\circ\ 20'\ 52'' \\ \Omega = & 14\ \ \ 4\ \ 56 \\ i = & 63\ \ 28\ \ 17 \end{array}\right\} \text{Mean Eq. } 1890{\cdot}0.$$

$$\log q = 9{\cdot}88007.$$

Ephemeris for Berlin Midnight.

1890.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log r.	Brightness.
Aug. 7	10 43 24	+28 1·0	0·2526	9·9826	0·50
8	10 47 12	27 10·4			
9	10 50 53	26 20·3	0·2601	9·9929	0·46
10	10 54 27	25 30·7			
11	10 57 55	24 41·7	0·2676	0·0033	0·43
12	11 1 16	23 53·2			
13	11 4 31	23 53	0·2752	0·0137	0·39
14	11 7 41	22 18·0			
15	11 10 45	21 31·2	0·2827	0·0240	0·36

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual summer meeting of the Institution of Mechanical Engineers was held last week in Sheffield. There could be no more appropriate centre around which either this Institution, or the sister Society, the Iron and Steel Institute, could gather. Sheffield has, however, of late years been somewhat tardy in offering a welcome to visitors. Six years ago it was proposed that the Iron and Steel Institute should hold a session in Hallamshire, but Hallamshire would not open its doors, and the Iron and Steel Institute had to journey to Chester. It is 29 years since the Mechanical Engineers met in Sheffield, and now, when they once more congregate there, they find but a partial welcome. The fact is, the big Sheffield steel makers—the Browns, Firths, Cammells, Jessops, and Vickers—have always pursued an absurd policy of secrecy. There is as much Abracadabra about these Sheffield steel makers as ever was practised by the alchemists of old. One can walk into the other steel works of the country with no more formality than presenting one's card, and see all that is to be seen; but these Sheffield works remain a sealed book. The reason given for this is that "The Foreigner" comes over here and learns too much, imparting no information in return. Unhappily for the cogency of this argument it is just the foreigner that the steel makers must admit. All those firms who do work for foreign Governments must admit foreign Government inspectors. These men come into the works to stay for months or even years. They are experts in the business they are engaged upon. They come and go where they will, ask what questions they will, make analyses, tests, and experiments at will; in short, they obtain a thorough and complete knowledge of everything that goes on. When they return home they would look on two or three hundred a year as an ample income, or a hundred pound note as a handsome consulting fee.

In the face of such facts is it not childish to shut out the necessary engineer, who simply wants to satisfy his scientific curiosity regarding the chief material he uses?

Although the big steel makers had shut their doors on the Sheffield visitors, there were still some things of interest left. Many of the older class of crucible steel makers were willing to explain the whole process of steel production as introduced by Huntsman one hundred years ago, and indeed were able to give practical illustrations of the same. Steel affords as much food for contemplation to the industrial economist as to the physicist and chemist. That the addition of less than one half of one per cent. of carbon should so entirely change the character of the metal is curious enough, although so familiar; but that the making of crucible cast steel should have stood, as it has, through the last century of industrial change and revolution is still more surprising. Watt, Faraday, and Thomson, nay, even Bessemer and Siemens, have lived and laboured without writing a single record on the process. Crucibles are still made by hand, charged by hand, pulled out of the fire by hand, teemed by hand, and in fact the steam-engine is not called into requisition throughout the process. The steel manufacturer makes no chemical analysis to find the grade of his steel. He breaks a piece, and his eye tells him by the fracture the percentage of carbon nearly enough for all practical purposes; *i.e.* as nearly as his neighbour knows, who does the same. And yet if one wants trustworthy steel of the highest grade one has to go to Sheffield for it, and pay the Sheffielder's price. All the science of all the engineers, chemists, and physicists of the last hundred years, allied with the industrial activity engendered by the fierceness of modern competition—even the mingling of science and commercial acumen, as in the persons of Siemens and Bessemer—has failed to unseat the ancient steel trade of Sheffield. No wonder the grimy town remains the stronghold of industrial empiricism, where they fall down and worship with the prophets of the rule of thumb.

But though the crucible steel maker is conservative in his method of working, he proved liberal in showing his work to others, and the members of the Institution had a good opportunity of seeing the way in which the finer kinds of steel they use are produced. The works of Messrs. Seebohm and Dieckstahll, Samuel Osborn and Co., and many others in which crucible steel making is carried on, were open to inspection; but, had not Park Gate come to the rescue, those who were unacquainted with the Bessemer or Siemens processes would have had to go to South Wales, Glasgow, or the north-east, where they could find works open to their inspection quite as well organized as any they missed seeing at Sheffield.

There were eight papers down for reading during the meeting, the sittings being held on the 29th and 30th ult. in the large hall of Firth College. The President of the Institution, Mr. Joseph Tomlinson, presided throughout. The papers on the agenda were as follows:—

"On Steel Rails, considered chemically and mechanically," by C. P. Sandberg, London.

"On Recent Improvements in the Mechanical Engineering of Coal Mines," by Emerson Bainbridge, of Sheffield.

"Description of the Park Gate Iron and Steel Works," by C. J. Stoddart.

"Description of the Sheffield Water Works," by Edward M. Eaton, Engineer.

"Description of the Loomis Process for making Gas Fuel," by R. N. Oakman, Jun., of London.

"On Milling Cutters," by George Addy, of Sheffield.

"On some Different Forms of Gas Furnaces," by Bernard Dawson.

"On the Elihu Thomson Electric Welding Process," by W. C. Fish, of London.

The first five papers only were read, the other three being adjourned until the next meeting.

Steel rails first occupied the attention of members, Mr. Sandberg opening the business part of the meeting by reading his paper. The author attributed the well-known greater durability of the first Bessemer rails made in Sheffield, to the hammered blooms and slow running mills of early days. There is no doubt that hardness is a virtue in railway lines, and hardness may be obtained by work; but it can also be obtained chemically. By the latter means, however, other desirable features may be jeopardized. In the tables showing results of tests, given as an appendix to the paper, this point was strongly brought out, the amount of phosphorus being, in the case of some Russian rails, exceedingly high, in fact dangerously so in the opinion of some of our best authorities. In dealing with the question of silicon, the author gave a seasonable reminder as to the different composition required for steel which was to be used in bridge and ship work, and that intended for rails. This point was taken up in the discussion, Messrs. Windsor Richards, Jeremiah Head, and others speaking on the question of mechanical tests. Tensile tests were generally pronounced as undesirable, being costly, and of little or no use; the falling weight test, and a test for hardness, together with such light as might be thrown by chemical analysis, being considered sufficient. It may be pointed out, however, that there is no well-established means of testing for hardness. Mr. Wicksteed spoke to the point when he referred to the desirability of ascertaining the percentage of elongation, although, as will be seen, this is not a sure guide. This question leads up to another which arose in the discussion. Some of the rail-makers present exclaimed against engineers insisting on steel containing a given percentage of certain alloys. The engineers have nothing to do with chemical analysis, the metallurgists say; it is a subject they know little or nothing about, and yet they lay down the law to the steel makers, whose business it is. Let the engineers be satisfied with results, and leave to those who understand the question the means of attaining these results. This is very good logic as far as it goes, but unfortunately it is not easy to make tests which will definitely settle the question of practical use. One speaker very well said that he looked on the Metropolitan Railway as the best testing machine for rails in the world; and so long as engineers find that a given chemical analysis gives a durable and safe steel rail, they will be justified in asking for that analysis as supplementary to mechanical tests. Speaking on the latter question, the author says in the paper: "As for tensile tests, they tell us very little; for soft rails broke at only 33 tons per square inch, instead of 41 tons for the good rails; while the brittle rails gave almost the same tensile strength as the good rails, and even more elongation and contraction." Could the transverse test under a falling ball have been substituted for these slow and costly tensile tests, it would have shown better the merits of safe or brittle rails. It may be mentioned in passing that the hardness machine of Prof. Turner, of Mason's College, Birmingham, to which Mr. Hadfield made reference, appears to promise well as a means of determining the second desirable feature in steel rails. By the tables to which reference has been made, it was shown that 0·24 per cent. of silicon in steel rails gave the best results. This the author considers the most striking feature in the analysis.

Mechanical engineering in coal-mines, as described in the contribution of Mr. Emerson Bainbridge, next occupied the attention of the meeting. We do not propose giving an abstract of this paper in the present notice; it would be like trying to run the River Thames through a 12-inch main. The author ranged over the whole field of mining engineering; the illustrations, which were shown by aid of the magic lantern, being more than a hundred in number. This paper had evidently cost the author much trouble and time in its preparation, and was one eminently fitted for the consideration of the members of the Institution of Mechanical Engineers. Mr. Bainbridge is well known in the north as a mining engineer of ability—a fact which it is well to emphasize, as his paper was received by some members, not themselves acquainted with its subject, in a very ungracious spirit. It is to be hoped that the proposal which he made to withdraw the paper from publication in the Transactions will not be carried out.

The papers of Messrs. Sandberg and Bainbridge were the only two taken on the first day of the meeting, the sitting being adjourned about one o'clock for the members to visit the various works open to their inspection.

On the members reassembling on the next day, Wednesday, the 30th ult., the first paper taken was that of Mr. C. J. Stoddart. The author is the managing director of the Park Gate Iron and Steel Works, and in his contribution he dealt with the new plant for steel making lately erected there. Should it ever be necessary to put these works into the market, the paper would form an excellent auctioneer's catalogue, it reading more like a document of that nature than a memoir to be put before a meeting of a scientific or technical Society. There were, however, a few passages of historic interest which we reproduce. These works, which are near Rotherham, were founded in 1823, and here many of the iron rails used on the first railways were rolled; amongst some of the later ones were those for the Metropolitan Railway, many of which were case-hardened. Here, also, were rolled a large part of the iron plates used in the construction of the *Great Eastern*; whilst armour plates were first rolled here also. The latter were presumably for the *Warrior*, as she was our first armour-clad ship, and they were very different from the compound steel and iron plates now so elaborately prepared, being, it will be remembered, no more than 4½ to 5 inches thick. Park Gate has, however, had to abandon these early methods of iron working, and, advancing with the times, has laid down within the last two years a costly steel plant, the outline particulars of which are duly set forth in Mr. Stoddart's catalogue. We are not, however, disposed to quarrel with the author of the paper for not going more fully into particulars, as he was liberal enough, in his capacity as managing director, to invite the meeting to make an excursion to his works on the day following the reading of his paper. The members were therefore enabled to see for themselves the five blast furnaces, plate and sheet mills, bar mills and their appurtenances, four 25-ton Siemens furnaces, cogging mills, slab rolls, billet mills, and plate mills duly set forth in the author's list of plant. The capacity of the steel works is from seven to eight hundred tons of steel and from four to five hundred tons of plates per week.

Mr. Oakman's paper on the Loomis process of making gas fuel was next brought before the meeting. The apparatus in which Loomis gas is made consists mainly of a generator and steam boiler. The generator is not novel in principle, the air being drawn through the charging door in the top, whilst an exhauster is used to set it in motion. The result is producer gas, which is superheated and then led through the boiler to produce steam, finally passing to the gas-holders. This part of the process is carried on for about five or six minutes, after which the admission of air is suspended, and the steam which has been generated is carried through the incandescent fuel, having been previously superheated in the superheater. The second operation produces, of course, water-gas, which, however, has one great advantage over ordinary water-gas, inasmuch as it possesses a strong and characteristic odour. This proceeds from the hydrocarbons taken up from the fuel, a bituminous coal being used. The apparatus has been applied with success in Sheffield, notably by the big steel house of T. Firth and Sons. A representative of that firm stated during the discussion that a saving of at least 50 per cent. in the cost of fuel in the manufacture of crucible steel was made by using Loomis gas, as compared with the old method of melting by coke—a statement which we have no difficulty in accepting when it is remembered how extremely wasteful is the present usual method of firing.

The discussion which followed the reading of the paper soon fell into the familiar groove which seems to have become stereotyped for use whenever the question of gas fuel comes to the fore. Mr. John Head and Sir Lowthian Bell both spoke. The former naturally soon brought the subject round to the Siemens furnace; upon the merits of which he was speaking

—especially in the matter of cheapness—when he was stopped by the President. The practice Mr. Head follows at meetings of the scientific and technical Societies is not tending to enhance the respect felt for the once honoured name of Siemens. Sir Lowthian Bell said what he said in Paris last year over again. The position he takes up—that no more heat can be got from a pound of fuel than Nature put in it—is perfectly sound, but there is no need to repeat the truism at such great length and so often.

The Sheffield Water Works was the subject of the last paper read at the meeting.

On the whole, it cannot be doubted that the meeting of the Mechanical Engineers at Sheffield was below the average, and badly managed. If Mr. Eaton's paper on the water-works had been taken as read, and Mr. Addy's contribution on milling cutters had been brought forward, the meeting might have done something to redeem its character as a representative assemblage of Mechanical Engineers. The Catalogue of the Park Gate Iron and Steel Works might also have been taken as read. Both the latter and the water-works paper were acceptable as guides to the respective excursions, but that was no reason why members should be required to sit and listen whilst Mr. Bache read through them at a speed which rendered it quite impossible to follow.

We have not space to refer to the visits to works in Sheffield open to visitors, and indeed there was not much of exceptional interest. Exception must be made, however, to a loom for weaving horse-hair cloth, which was seen at the works of Laycock and Sons. The wonderful ingenuity displayed by designers of textile machinery appears here to have reached its culminating point. Horse-hair has several undesirable features from a textile point of view. The filaments are generally no longer than 3 or 4 feet; though exceptional hairs have been known as long as 6 feet, we believe. The thickness differs considerably at each end; the material is very elastic, and it is so hard that it will speedily wear away the hardest steel over which it may be dragged. In order to overcome these difficulties, the designer of this loom, Mr. W. S. Laycock, has introduced a shuttle with jaws that take hold of each hair as it is presented, and a device which is known as the selector. The latter is a hand—for we can call it nothing less—which picks up one hair, and only one, to present to the jaws of the shuttle. It has to let go at the very instant the shuttle takes hold, otherwise the hair would be dragged through its fingers, which would soon be worn away. Sometimes, however, the fingers fail to grasp this single hair; it must be remembered if it were to take two hairs the cloth would be spoiled. It then makes a second try, and, if the second fail, yet a third. Supposing the third attempt also prove unsuccessful, there being no time to make a fourth, the selector promptly stops the weft motion, so that no change takes place whilst the shuttle is making its traverse without a hair to form the weft. Theophrastus Such, after a visit to a textile factory, had a nightmare, in which mechanism usurped the place of humanity, and became the inexorable master of mankind. The conceit is worked out with much skill, and appears quite plausible when viewed in the light of mechanism which not only performs the most delicate operations, but knows when it misses, tries again as long as trying is of avail, and, if it fail at last, takes steps to prevent mischief following.

ON THE ORIGIN OF THE DEEP TROUGHS OF THE OCEANIC DEPRESSION: ARE ANY OF VOLCANIC ORIGIN?[1]

THE consideration of the question with regard to the origin of the ocean's deep troughs requires, as the first step, a general review of oceanic topography; for according to recent bathymetric investigations, the deep troughs are part of the system of topography, and its grander part. We need, for this purpose, an accurate map of the depths and heights through all the great area. Such a map will ultimately be made through the combined services of the Hydrographic Departments of the civilized nations. At the present time the lines of soundings over the oceans, especially over the Pacific and Indian, are few, and only some general conclusions are attainable. It is to be noticed that the system of features of the oceanic area are involved in the more general terrestrial system; but since the former comprises nearly three-fourths of the surface of the sphere, it is not a subordinate part in that system.

With reference to this discussion of the subject I have prepared the accompanying bathymetric map.

I. THE BATHYMETRIC MAP, AND THE GENERAL FEATURES OF THE OCEANIC DEPRESSION DISPLAYED BY IT.

1. *The Map.*—In the preparation of the bathymetric map I have used the recent charts of the Hydrographic Departments of the United States and Great Britain,[1] which contain all depths to date, and the lists of new soundings published in German and other geographical journals. In order that the facts on which the bathymetric lines are based may be before the reader a large part of the depths are given, but in an abbreviated form, 100 fathoms being made the unit: 25 signifying 2500 fathoms or nearly (between 2460 and 2550); 2·3, about 230 fathoms, ·4, about 40 fathoms. Only for some deep points is the depth given in full. The addition of a plus sign (+) signifies no bottom reached by the sounding.[2]

In the plotting of oceanic bathymetric lines from the few lines of soundings that have been made, the doubts which constantly rise have to be settled largely by a reference to the general features of the ocean, and here wide differences in judgment may exist in the use of the same facts; but through the depths stated on the map, the reader has the means of judging for himself. In the case of an island the lines about it may often have their courses determined by those of adjoining groups, or by its own trend; but in very many cases new soundings are needed for a satisfactory conclusion.

Some divergences on the map from other published bathymetric maps require a word of explanation. The northern half of the North Pacific is made, on other deep-sea maps, part of a great 3000-fathom area (between 3000 and 4000) stretching from the long and deep trough near Japan far enough eastward to include the soundings of 3000 fathoms and over in mid-ocean along the 35th parallel. It has seemed more reasonable, in view of present knowledge from soundings, to confine the deep-sea area off Japan to the border-region of the ocean, near the Kurile and Aleutian Islands, and leave the area in mid-ocean to be enlarged as more soundings shall be obtained. Again, in the South Pacific, west of Patagonia, the area of relatively shallow soundings (under 2000 fathoms) extending out from the coast, is on other maps bent southward at its outer western limit so as to include the area of similar soundings on the parallels of 40° and 50°, between 112° and 122° W. The prevailing trends of the ocean are opposed to such a bend, and more soundings are thought to be necessary before adopting it.

It may be added here that in the Antarctic Atlantic, about the parallel of $66\frac{1}{2}^\circ$ S. and the meridian of $13\frac{1}{2}^\circ$ W., a large area of 3000 and 4000 fathoms has been located. It was based, as I have learned from the Hydrographic Department of the British Admiralty, on a sounding in 1842 by Captain Ross, R.N., in which the lead ran out 4000 fathoms without finding bottom. The sounding was, therefore, made before the means available were "sufficient to insure the accuracy of such deep casts."[3]

2. *The Feature-lines of the Oceanic and Bordering Lands.*—The courses of island-ranges and coast-lines have a bearing on the question relating to the courses of the deep-sea troughs, and

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[1] This paper is accompanied in the *American Journal of Science* from which it is reprinted, by a bathymetric map.

[1] I am indebted to the Hydrographic Departments of Great Britain as well as the United States for copies of these charts.

[2] On the map the bathymetric lines for 1000, 2000, 3000, and 4000 fathoms, besides being distinguished in the usual way by number of dots, have been made to differ in breadth of line, the deeper being made quite heavy in order to exhibit plainly the positions of the areas without the use of colours. The line for 100 fathoms is, as usual, a simple dotted line. As the bathymetric map herewith published is necessarily small, and none of the ordinary maps of the oceans give either deep-sea soundings or a correct idea of the trends of the oceanic ranges of islands, I state here that the charts of the U.S. Hydrographic Department for the Atlantic, Pacific, Indian, and Arctic Oceans may be purchased of dealers in charts in the larger sea-board cities for 50 cents a sheet and less according to size. (There are several large charts to each ocean.) One of the firms selling them in New York City is that of T. S. and J. D. Negus, 140 Water Street. The British Admiralty have published a map of the Pacific with its soundings on a single sheet, and for the Atlantic and Indian Oceans with part of the Pacific, besides charts of the Antarctic and Arctic seas. The occasional Bulletins from the Hydrographic Department and *Petermann's Mitteilungen* contain nearly all the new data issued for the perfecting of such a chart.

[3] The communication received from the Admiralty Office adds that "Some of Ross's soundings up to 2660 fathoms have been proved correct, and hence the sounding in 68° S., referred to, has been retained on our charts until disproved." "Another sounding obtained by Ross in the Atlantic has had strong doubts thrown upon it by a sounding of 3000 fathoms obtained not very far from its position." See the accompanying map, near latitude 14° S.